Upper Ureteral Stone Treatment: Effectiveness and Complications of Holmium Laser and Pneumatic Lithotripsy

Üst Üreter Taşlarının Tedavisinde: Holmiyum Lazer ve Pnömotik Litotripsinin Etkinliği ve Komplikasyonlar Üzerine Etkisi

Ureteral Stone Treatment

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Özet

Amaç: Bu çalışmada üst üreter taşlarının tedavisi için üreterorenoskop kullanılarak yapılan Holmiyum: YAG (Hol: YAG) lazer ve pnömotik litotripsi uygulamalarının başarı ve komplikasyonlar üzerine etkisini karşılaştırmayı amaçladık. Gereç ve Yöntem: Ekim 2011 ile Şubat 2014 tarihleri arasında üst üreter taşı nedeniyle üreterorenoskopi yapılan 249 hasta retrospektif olarak incelendi. Preoperatif ve postoperatif kontrastsız batın tomografisi olmayan hastalar çalışma dışında bırakıldı. Tüm hastaların taşları üst üreter lokalizasyonunda olup görüntülemelerinde üreteropelvik bileşkede taşları olan hastalar değerlendirme dışı bırakıldı. 114 hasta çalışmaya dahil edildi. Hastalar cinsiyet, yaş, taş lokalizasyonu, taş büyüklüğü, üreteral kateterizasyon, taş migrasyonu, rezidü taş, operasyon süresi, komplikasyon, daha önce ESWL uygulaması ve hastanede kalış süreleri yönüyle değerlendirildi. Hol: YAG lazer uygulanan hastalar Grup 1 ve pnömotik litotripsi uygulanan hastalar ise Grup 2 olarak ayrıldı. Bulgular: Grup 1'de 60 (%52.63) hasta, Grup 2'de ise 54 (%47.36) hasta vardı. Taş büyüklükleri Grup 1'de 8,21±2,40 mm, Grup 2' de 8,68±1,70 mm idi. Grup 1'de 53 (%88.33) hastada taşsızlık saptanır iken, 7 (%11.66) hastada rezidü taş (5 olguda migrasyon) bulunmaktaydı. İkinci grupta ise 41 (%75.92) hastada taşsızlık saptanır iken, 13 (%24.07) hastada rezidü taş (11 olguda migrasyon) bulunmaktaydı. Hastaların ortalama hastanede kalış süreleri Grup 1'de 1.09±0.37 (gün), Grup 2'de ise 1.2±0.32 (gün) idi. Gruplar arasında üreteral kateterizasyon, taş migrasyonu, rezidü taş, operasyon süresi, komplikasyon, daha önce ESWL uygulanması ve hastanede kalış süreleri yönünden istatiksel farklılık tespit etmedik. Tartışma: Üst üreter taşlarının tedavisinde lazer ve pnömotik litotripsi arasında başarı ve komplikasyonlar üzerine etki yönünden anlamlı fark bulunmamıştır.

Anahtar Kelimeler

Üreter Taşı; Üreterorenoskopi; Lazer Litotripsi; Pnömotik Litotripsi

Abstract

Aim: In this study, we aimed to compare the success and the effects on the complications of the Holmium:YAG (Hol:YAG) Laser and pneumatic lithotripsy applications done by using ureterorenoscope for the treatment of upper ureter stones. Material And Method: 249 patients who were applied ureterorenoscopy due to the upper ureter stones between October 2011 and February 2014 were analyzed retrospectively. 114 patients were included in the study. Patients were evaluated about the gender, age, stone localization, stone size, ureter catheterization, stone migration, residual stone, duration of the operation, complication, previous ESWL application and hospitalization period. Patients who were applied Hol:YAG laser were grouped as Group 1 and patients who were applied pneumatic lithotripsy were grouped as Group 2. Results: There were 60 patients (52.63%) in Group 1 and 54 patients (47.36%) in Group 2.Stone sizes were 8,21±2,40 mm in Group 1 and 8,68±1,70 mm in Group 2. It was detected that 53 patients (88.33%) of the Group 1 were stone-free while there was residual stone (5 case migration) in 7 patients (11.66%). On the other hand, in Group 2, 41 patients (75.92%) were stone-free and there was residual stone (11 case migration) in 13 patients (24.07%). We did not detect any difference in terms of the ureter catheterization, stone migration, residual stone, operation duration, complication, previous ESWL application and hospitalization period between the groups. Discussion: Any statistically significant difference between the laser and pneumatic lithotripsy in the treatment of upper ureter stones could not be foundon success and the effects on the complications.

Keywords

Ureter Stone; Ureterorenoscopy; Laser Lithotripsy; Pneumatic Lithotripsy

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Introduction

Urinary system stone disease, one of the oldest known diseases, causes many negative effects, including recurrent stones and renal failure [1]. The classical treatment for ureter stones is open surgery; however, ureterorenoscopy (URS) has become the first choice for surgical treatment [2]. Currently, URS is widely used in the diagnosis and treatment of urinary system diseases. With the development of ureteroscopic tools and the use of lithotripter equipment, the success rate of endoscopic treatment for ureter stones has increased. European and American urology guides suggest that conservative and medical expulsive therapies should be considered first. Patients should be followed closely to monitor stone progression, hydronephrosis formation, and symptoms, and surgery should be performed in cases of continuing obstruction, non-progressing stones, and increasing or chronic renal colic for ureter stones less than 10 mm in size. For ureter stones that are greater than 10 mm in size, extracorporeal shock wave lithotripsy (ESWL) or an endoscopic approach is considered the best treatment [2].

Various types of lithotripsy, which utilize different energy systems, are used for the treatment of ureter stones, including electro hydraulic, pneumatic, ultrasonic, and laser lithotripsy. There are advantages and disadvantages to each type of lithotripsy. In this study, we compared the effectiveness and associated complications of pneumatic lithotripsy and Ho:YAG laser in upper ureter stone fragmentation.

Material and Method

In total, 249 patients who underwent URS due to upper ureter stones between October 2011 and February 2014 were analyzed retrospectively. Patients who did not undergo preoperative and postoperative non-contrast abdominal tomography were excluded from the study. All of the patients' stones were in the upper ureter; those patients who had stones in the ureteropelvic (UP) junction were excluded from the evaluation. The area between the upper part of the pelvic bone and UP junction was defined as the upper ureter. In total, 114 patients were included in the study. The patients were evaluated for sex, age, stone localization, stone size, ureter catheterization, stone migration, residual stones, duration of surgery, complications, previous application of ESWL, and hospitalization period. A complete urinalysis, urine culture, renal function tests, hemogram, and biochemical tests were performed for all patients. Imaging of the patients before surgery was performed by non-contrast computerized tomography (CT). A control was prepared by direct urinary system graphy for stone localization in the morning on the day of surgery. Those patients treated with a Hol:YAG laser for stone fragmentation were assigned to Group 1, while those patients who underwent pneumatic lithotripsy were assigned to Group 2. A Hol:YAG laser (4.0 W, 0.8–1.5 J, 0.5–1 Hz) (Quanto System Laser Litho, Italy) was used in Group 1, while a Vibrolith™ lithotripter (1.5-mm probe; average pressure, 5 bar; beat frequency, 400 s/m) (Elmed, Turkey) was used for the same process in the other group. While the fragments were allowed to pass freely, those fragments with a larger diameter, which could not pass freely, were removed with stone forceps. A Stone Cone™ (Boston Scientific, Natick, MA, USA) catheter was used to prevent the migration of stone fragments. Cases in which a Stone Cone™ catheter was not used were not included in the study. A double j (DJ) ureter stent was placed into the ureter in cases with intense mucosal edema, lacerations, or residual stone presence. All patients were assessed for residual stones by non-contrast, thin-slice helical CT (2 mm section thickness) in the second postoperative week. Success was defined as no evidence of residual stones of >2 mm in diameter. A statistical analysis of the data was performed using SPSS for Windows, version 22.0 (SPSS Inc., Chicago, IL, USA). The evaluation was performed using Mann-Whitney U and chi-square tests. All tests were considered significant at $p < 0.05$.

Results

Of the patients, 66 (57.89%) were male and 48 (42.10%) were female; the average age was 38.12±11.13 (years). There were 60 patients (52.63%) in Group 1 and 54 patients (47.36%) in Group 2. The stone sizes were 8.21±2.40 mm in Group 1 and 8.68±1.70 mm in Group 2. A history of ESWL was identified in 47 patients in Group 1 and 44 patients in Group 2. The data for Groups 1 and 2 are presented in Table 1. We found that 53 patients (88.33%) in Group 1 were stone-free, while 7 (11.66%) had a residual stone (5 cases of migration). On the other hand, in Group 2, 41 patients (75.92%) were stone-free and residual stones (11 cases of migration) were detected in 13 patients (24.07%). The average hospitalization period of the patients was 1.09±0.37 days in Group 1 and 1.2±0.32 days in Group 2. We did not detect any differences in terms of ureter catheter-

Table 1. Data for Groups 1 and 2

		Group 1 (n:60)	Group 2 (n:54)	p
Age Average±SD (Median 25–75%)		39.18±13.54 37.50 (29.25–47.75)	41.50±12.62 42.00 (31.25–53.00)	p=0.288
Sex	Male (n/%)	36/54.5	30/45.5	p=0.772
	Female (n/%)	24/50	24/50	
History of ESWL	Yes (n/%)	47/51.6	44/48.4	p=0.854
	No (n/%)	13/56.5	10/43.5	
Side	Left (n/%)	23/46.9	26/53.1	p=0.386
	Right (n/%)	37/56.9	28/43.1	
Stone size (mm) Average±SD (Median 25–75%)		8.21±2.40 8.00 (6.00–10.00)	8.68±1.70 9.00 (8.00–10.00)	p=0.121
Anesthesia	Spinal (n/%)	22/51.2	21/48.8	p=0.959
	General (n/%)	38/53.5	33/46.5	
Operation duration (min) Average±SD (Median 25–75%)		35.75±14.66 30.00 (25.00–45.00)	34.90±14.38 30.00 (25.00–45.00)	p=0.874
Migration	No (n/%)	53/56.4	41/43.6	p=0.136
	Yes (n/%)	5/31.2	11/68.8	
DJ catheterization	No (n/%)	40/51.9	37/48.1	p=0.922
	Yes (n/%)	20/54.1	17/45.9	

ization, stone migration, residual stones, duration of surgery, complications, previous ESWL, and hospitalization period between Groups 1 and 2 (Table 2). We could not find any statistical difference between Groups 1 and 2 in terms of complications.

Table 2. Complications in Groups 1 and 2

Complication	Group 1	Group 2	Clavien degree
Macroscopic hematuria (n/%)	15/25	13/24.1	Grade 1
Fever (n/%)	2/3.3	4/7.4	Grade 1
Ureter damage (n/%)	6/10	7/12.9	Grade 1
Pain (n/%)	4/6.6	6/11.1	Grade 1

In Groups 1 and 2, those patients with residual stones underwent ESWL. None of the patients underwent a second round of endoscopy. There were no major complications (e.g., ureter perforation and severe bleeding) in either group. The incidence of superficial mucosal damage was 10% in the laser lithotripsy group and 12.96% in the pneumatic lithotripsy group; a DJ stent was placed in each of these patients. Data related to the complications in Groups 1 and 2 are presented in Table 2.

Discussion

The recent development of ureteroscopes with a decreased diameter and intracorporeal lithotripsy have enabled less traumatic and more successful ureteroscopic stone treatments. Currently, laser and pneumatic lithotripsy are widely used. For upper ureter stones, if there is no advanced obstruction due to the stone, less than 10 mm and if the stone is opaque, ESWL may be considered as the first treatment choice [2]. URS is a minimally invasive method of treatment. Therefore it is the first choice of treatment or after ESWL [3]. In America, for upper urinary tract stones, rates of ESWL and URS procedures were 54% and 42%, respectively [4]. URS is the preferred method for treating upper urinary system stones according to an evaluation performed in our country by Güner et al. [3--5]. However, in our department are primarily preferred ESWL treatment .

Strohmaier et al. reported that in the use of URS for the treatment of ureter stones, less successful outcomes and more complications were seen in patients with a history of ESWL [4--6]. They linked the lack of successful treatment in those cases primarily to mucosal edema. Still, Tuğcu et al. stated that surgery was more difficult because of mucosal edema and impacted stones after ESWL in a study in which they analyzed the effects of distal ureter stone size on the outcome of ureteroscopy [5--7]. In our study, 79.8% of the patients had a history of ESWL. We found that those patients had greater mucosal edema; thus, they received DJ catheters more often.

In a study by Günlüsoy et al. pneumatic lithotripsy was used in 1296 ureter stone cases, and the success rates were 98.1, 93.1, and 90.5% for the lower, middle, and upper ureter, respectively [6--8]. Hong and Park reported a success rate of 80.3% for URS done with pneumatic lithotripsy for the treatment of upper ureter stones [7--9]. On the other hand, Fang et al. reported an 88% success rate for laser lithotripsy [8--10]. Değirmenci et al. reported a stone-free rate of 81.8% in patients who underwent laser lithotripsy for an upper ureter stone [9--11]. Still, Kassem et al. reported the early stone-free rate equal in both groups, while the delayed stone-free rate 95% in laser lithotripsy and 85% in pneumatic lithotripsy [10--12]. In our study, the stone-free rate was 88.3% in the laser group and 75% in the pneumatic lithotripsy group. According to our study, there was no statistically significant difference between laser and pneumatic lithotripsy in terms of success.

The migration of a stone or its fragments to the proximal collector system is a significant problem in ureteroscopic lithotripsy. When Tipu et al. compared laser and pneumatic lithotripsy as part of a prospective study, they detected significantly different migration rates of 4 and 16%, respectively [11--13]. In a prospective study, Maghsoudi et al. reported stone migration in 2.4% of patients who received laser lithotripsy for upper ureter stones and in 7.3% of patients who received pneumatic lithotripsy, but the difference was not statistically significant [12--14]. However, in our study, we detected a migration rate of 8.3% for laser lithotripsy, as compared to 20.3% for pneumatic lithotripsy. Although laser lithotripsy might be seen as more advantageous than pneumatic lithotripsy in terms of migration, no statistically significant difference was observed. We believe that the lack of a statistically significant difference might be due to the use of Stone Cone™ catheters. However, the push effect of pneumatic lithotripsy increases the mobility of stones; thus, a stone collector catheter should be used.

For both the migration of stones to the upper urinary system and damage to the upper ureter mucosa caused by endoscopic ureter stone treatment, DJ catheter placement might be necessary. Tipu et al. reported DJ catheterization in 10% of patients who underwent laser lithotripsy, as compared to 26% in patients who underwent pneumatic lithotripsy [10]. In our study, DJ catheterization was applied in 54.1% of patients in the laser lithotripsy group and 45.9% of patients in the pneumatic lithotripsy group. According to the literature, these high ureter catheterization rates might be due to the fact that ESWL had previously been applied to a large number of patients, resulting in increased inflammation of the ureter mucosa.

Ureteroscopic lithotripsy and stone removal procedures are used for stones at all levels of the ureter. Minor and major complications are possible during this process. The Clavien system defines minor complications that can be treated only with drugs as grade 1. In our study, in Groups 1 and 2, only minor complications were observed; thus, according to the Clavien system, no higher grade complication than grade 1 was detected. Although the complication rates were higher in the pneumatic lithotripsy group than in the laser lithotripsy group, no statistically significant difference was observed between Groups 1 and 2.

Conclusions

We did not find any significant difference between laser and pneumatic lithotripsy for the endoscopic treatment of upper ureter stones in terms of effectiveness and complications. Placement of a stone collector catheter is useful for the prevention of stone migration in upper ureter stone treatment. According to our study, URS is a successful and safe method for the surgical treatment of upper ureter stones, independently of lithotripsy.

Competing interests

The authors declare that they have no competing interests.

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